Press Releases

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JAMSTEC

High flux of organic matter and highly active microbe communities discovered in the Mariana Trench's Challenger Deep, the world's deepest oceanic site

Overview

A research team of JAMSTEC, BioGeos, headed by Dr. Hiroshi Kitazato, Research Director of the Institute of Biogeosciences, Japan Agency for Marine-Earth Science and Technology (JAMSTEC; president: Asahiko Taira), together with colleagues from the University of Southern Denmark, Max Planck Institute for Marine Microbiology, University of Copenhagen, Scottish Association for Marine Science and other organizations has succeeded in taking in situ measurements of the oxygen concentration in sediments of the Mariana Trench's Challenger Deep, the world's deepest oceanic site with a depth of 10,813–10,900 m. This is the first in-situ measurements that have been made of sediments lying at depths of over 10,000 m. The team also collected core samples of the sediment and analyzed organic matter found in the samples. From measurements and analyses of the samples, the team found that, compared with sediment samples taken from the surrounding abyssal plain (a gently sloping deep ocean floor) at depths of 6018–6071 m, the Challenger Deep sediments showed: (1) higher oxygen consumption in conjunction with the decomposition of organic matter, an indicator of microbial activity; (2) higher concentrations of organic carbon (an indicator of the amount of organic matter), chlorophyll a (derived from phytoplankton, a convenient source of nutrition), and pheophytin1 (a product of chlorophyll decomposition); and (3) higher concentrations of bacteria, Archaea, and other microbes.

These results show the flux of organic matter and microbial activity to be higher in the seabed of the Challenger Deep than in that of the abyssal plain. This challenges conventional assumptions regarding deep sea ecosystems that the amount of organic matter reaching the seabed and the metabolism of organisms decline as depth increases.

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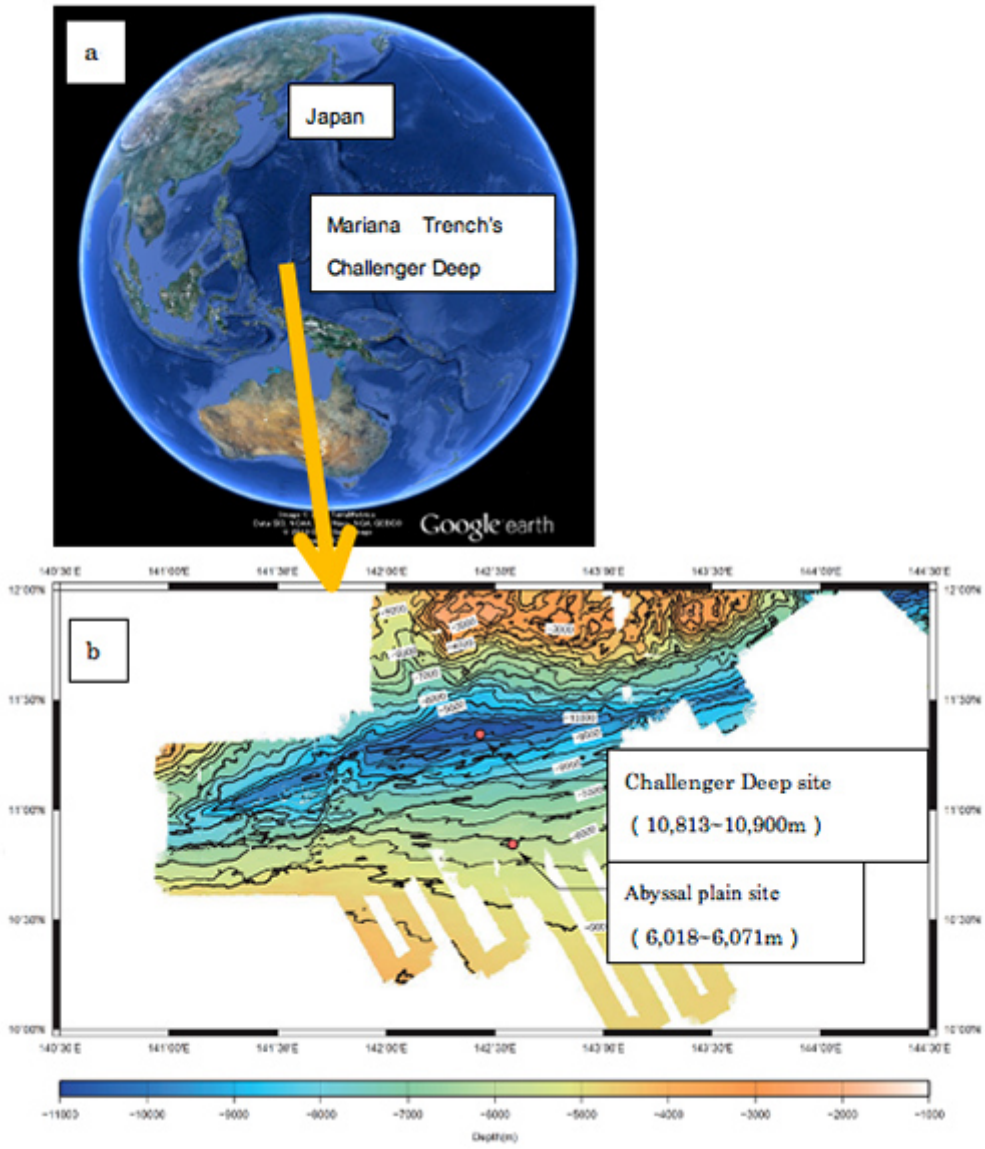

Figure 1. Map of study area
a: Position of the Mariana Trench and Challenger Deep; b: Surveyed sites.
A total of 4 samplings were made at the Challenger Deep site, and 3 at the abyssal plain site.

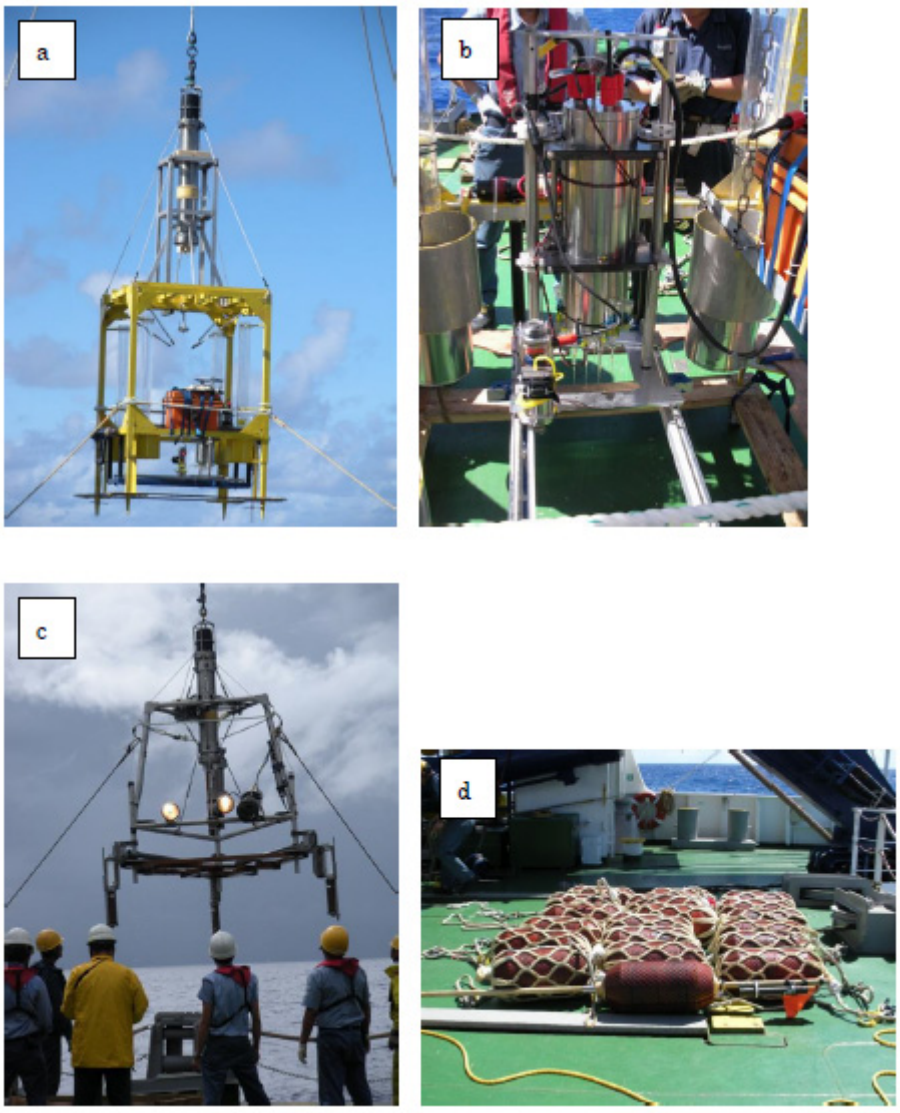

Figure 2. The 2 free-fall landers and auxiliary equipment used for the project
a: The free-fall lander developed jointly by the University of Southern Denmark, Scottish Association for Marine Science, and Max Planck Institute for Marine Microbiology, and reinforced by JAMSTEC to withstand high pressure. A variety of equipment is attached to the aluminum frame, including flotation buoys, weights, an acoustic release, and sensors. The lander is deployed from the vessel and measurements taken by the sensors after it reaches the seabed. After measurements have been made, an acoustic signal sent from the vessel is picked up by the acoustic release, causing the weights to be released. The lander becomes buoyant as a result, rising to the surface to be recovered by the vessel.
b: The ultrathin oxygen sensor unit attached to the lander shown in a. The unit measures the vertical distribution of oxygen in seabed sediment when the oxygen sensors, which are no more than several dozen micrometers in width (about the width of a needle tip) at their tips, are inserted 0.5–1.0 mm at a time into the seabed by using a high-precision motor so as not to disturb the sediment environment. Once measurements have been taken, the sensors are raised and the unit is moved horizontally to take further measurements in a slightly different location.
c. The free-fall lander developed by JAMSTEC equipped with a sediment sampling system and video camera. It is operated by using the same methods as those for the lander shown in a. The lights are switched on to allow video filming. The sediment corers on the legs contain collected sediment samples.
d: Some of the flotation buoys used for both free-fall landers. They are made from a special resin that contains microscopic glass spheres to ensure that they can even withstand the high-pressure environment at water depths greater than 10,000 m.

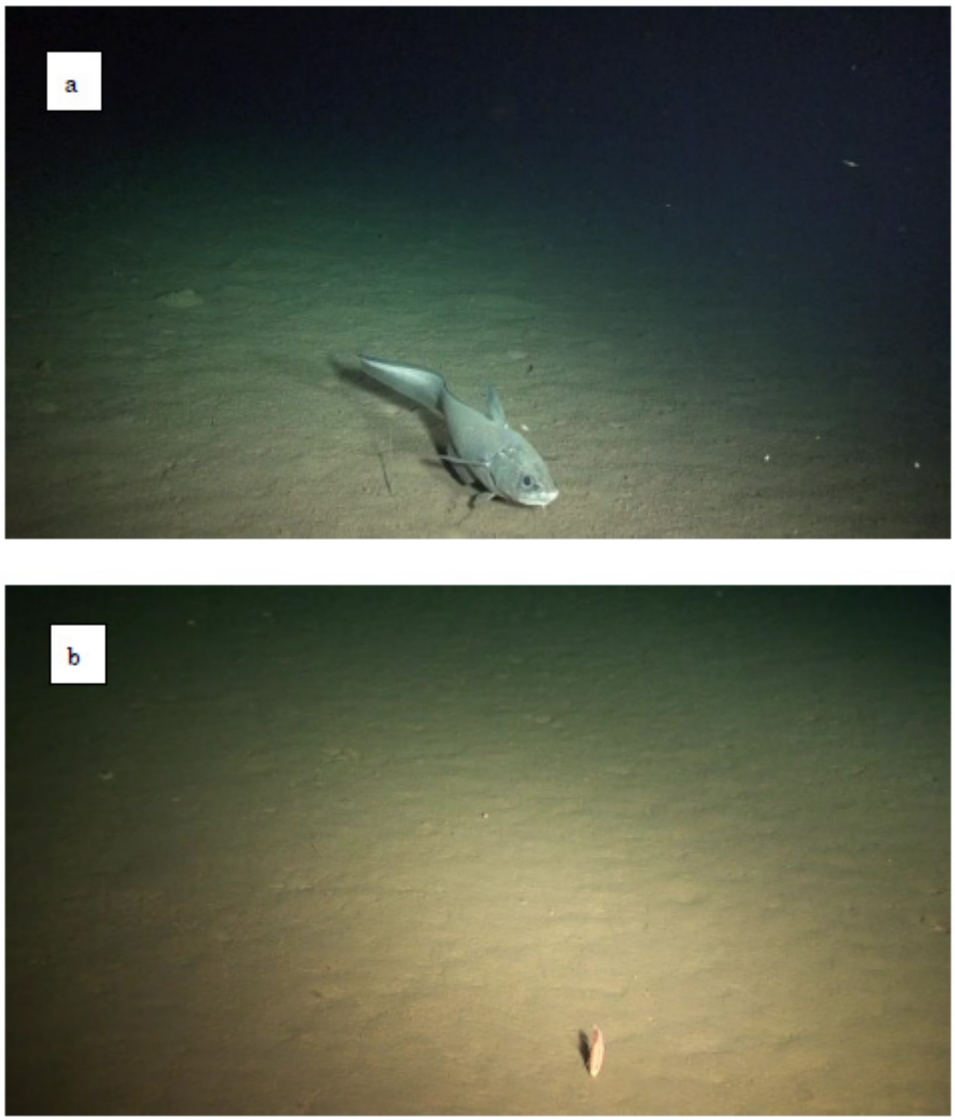

Figure 3. The seabed as filmed by the camera of the sediment sampling system. a: At the abyssal plain site (water depth 6032 m) and b: the Challenger Deep site (water depth 10, 900 m). Benthic organisms and mound-like structures presumably created by them were observed on the seabed of the abyssal plain site. Fish species and other larger fauna were also seen. No structures created by benthic organisms were seen on the seabed of the Challenger Deep, although faint ripple marks caused by currents were visible. No fish or other larger species were found at this depth, although the amphipod species Hirondellea gigas, holothurians, and other smaller creatures were visible, albeit in sparse numbers.

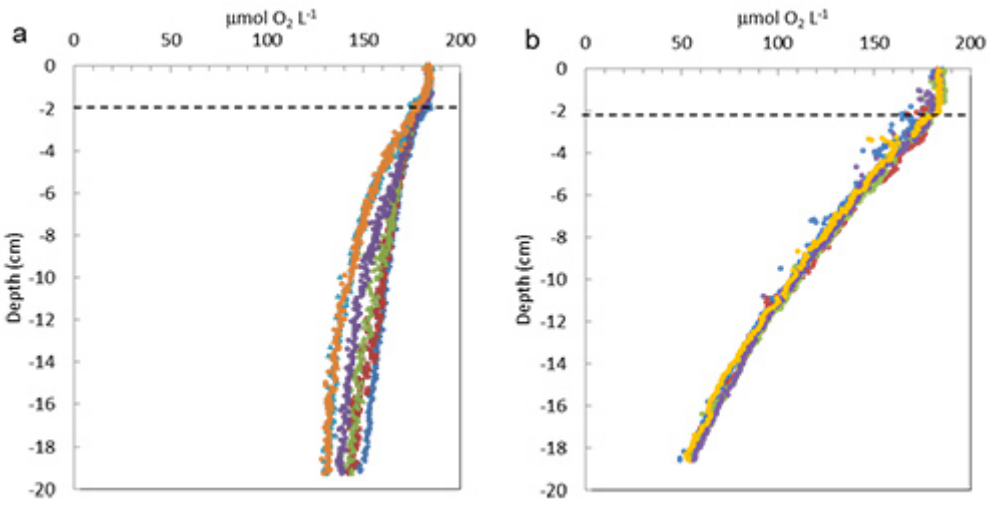

Figure 4. Vertical distribution of oxygen concentration in the seabed of a: the abyssal plain site (water depth of 6018 m) and b: the Challenger Deep site (water depth of 10, 817 m). Oxygen decline in the sediment of the abyssal plain site is slight compared with that of the Challenger Deep site. This suggests that in the sediment of the Challenger Deep site, oxygen consumption is higher, and therefore, that aerobic decomposition of organic carbon is highly active.

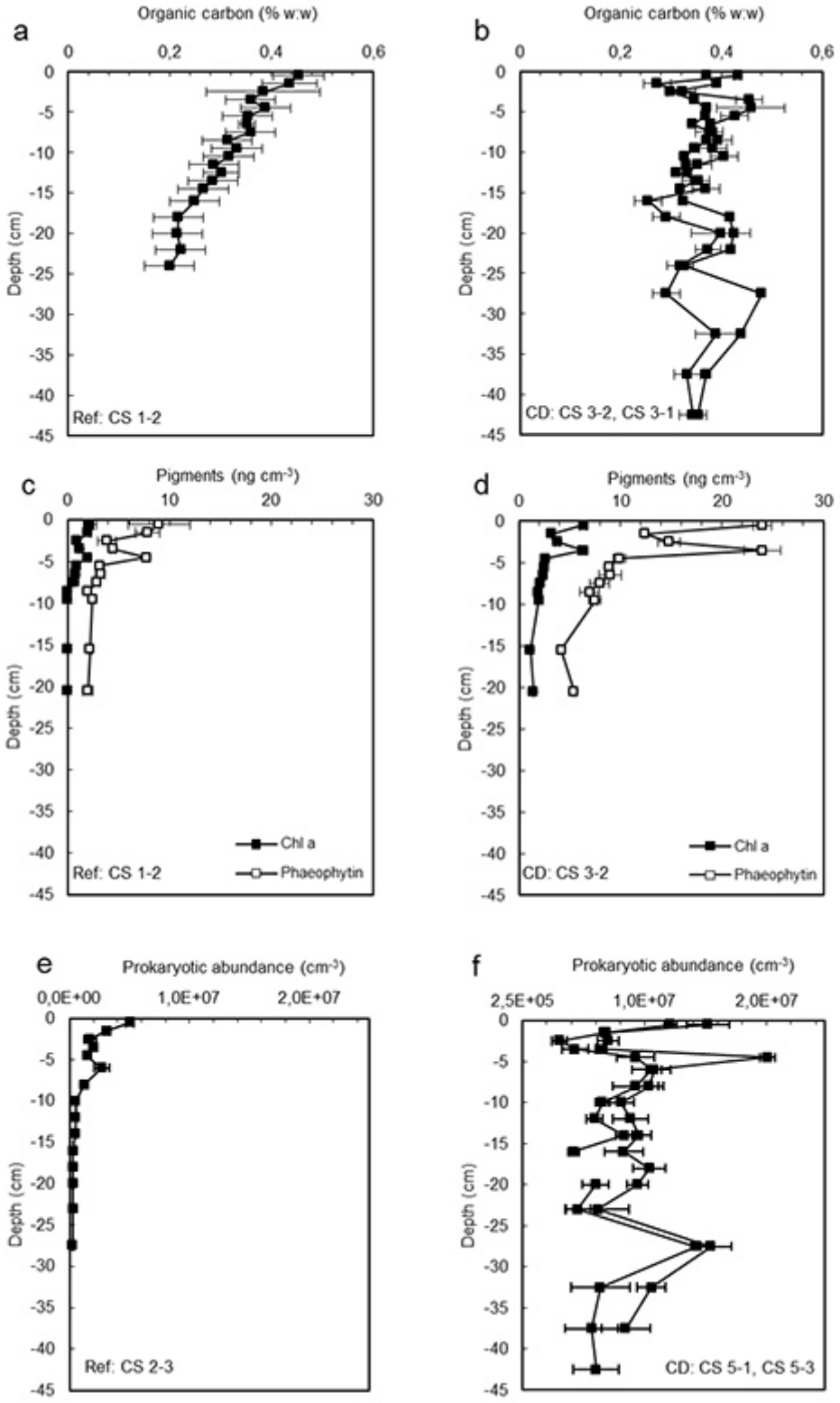

Figure 5. a, b: organic carbon concentration; c, d: chlorophyll a and pheophytin concentrations; e, f: density of microbes (prokaryotes). a, c, and e show the analysis results of the abyssal plain site sediment, and b, d, and f those of the Challenger Deep site sediment.

Contacts:
Japan Agency for Marine-Earth Science and Technology (JAMSTEC)
(For the study)
Dr. Hiroshi Kitazato,
Research Director , Institute of Biogeosciences (BioGeos)
Dr. Kazumasa Oguri,
Institute of Biogeosciences (BioGeos), Earth and Life History Research Program,
Geobiology Research Team

(For publication)
Mr. Kazushige Kikuchi, Director
Planning Department Press Office